SUBCOURSE EN5144

EDITION B

US ARMY ENGINEER SCHOOL

INSTALL SYSTEM, EQUIPMENT AND COMPONENT GROUNDS

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THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM

AIPD

READINESS / PROFESSIONALISM THRU GROWTH

INSTALL SYSTEM, EQUIPMENT, AND COMPONENT GROUNDS

Subcourse Number EN 5144

EDITION B

United States Army Engineer School
Fort Leonard Wood, Missouri 65473

5 Credit Hours

Edition Date: October 1999

SUBCOURSE OVERVIEW

This subcourse is designed to teach the knowledge necessary to install grounding electrodes and circuit grounds. The subcourse contains two lessons relating to Soldier Training Publication (STP) 5-51R12-SM-TG, Task 051-246-1104, Install Grounding Systems Equipment and Component Grounds.

There are no prerequisites for this subcourse.

This subcourse reflects the doctrine which was current at the time it was prepared. In your own work situation, always refer to the latest official publications.

Unless otherwise stated, the masculine gender of singular pronouns is used to refer to both men and women.

*This publication contains copyrighted material.

Appendix A contains a metric conversion chart.

TERMINAL LEARNING OBJECTIVE

ACTION: You will describe the procedures used to install grounding systems.

CONDITION: You will be given the material in this subcourse, a number (No.) 2 pencil, and an Army Correspondence Course Program (ACCP) examination response sheet.

STANDARD: To demonstrate competency of this task, you must achieve a minimum of 70 percent on this subcourse.

*Table 2-1, page 2-4; Table 2-2, page 2-5; and Table 2-3, page 2-8, were extracted from the National Electrical Code (NEC), printed and distributed by the National Fire Protection Association.

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LESSON 1

INSTALL GROUNDING ELECTRODES

Critical Task: 051-246-1104

OVERVIEW

LESSON DESCRIPTION:

In this lesson, you will learn to describe the procedures used to install grounding electrodes.

TERMINAL LEARNING OBJECTIVE:

ACTION: You will learn to describe the procedures used to install grounding electrodes.

CONDITION: You will be given the material contained in this lesson. You will work at your own pace and in your own selected environment with no supervision.

STANDARD: You will correctly answer the practice exercise questions at the end of this lesson.

REFERENCES: The material contained in this lesson was derived from STP 5-51R12-SM-TG and Section 250 of the NEC.

INTRODUCTION

An electrician's most important concern is to ensure that all electrical circuits are grounded. In this lesson, you will be shown how to properly select and place grounding electrodes. As an electrician, you must be able to install and test electrical circuits to ensure that you have a proper ground.

1-1. Systems. Grounding systems are installed using grounding rods, conductors, or plates. Grounding rods must be copper, steel, or iron/steel (galvanized) pipe that is at least 8 feet long. Ground resistance must be less than 25 ohms to ground (earth). In order to get resistance below 25 ohms to ground, you may need to drive a ground rod deeper than 8 feet, install additional rods, or add chemicals to the soil. Metal water pipes can be used to supplement a grounding system. One of the most important parts of electrical installation is the grounding rod (Figure 1-1, page 1-2).

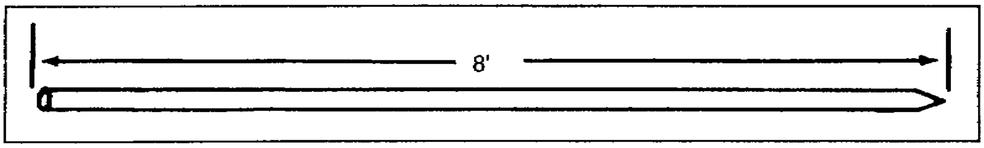

Figure 1-1. Grounding rod

a. The best grounding rod (electrode) is made of copper (nonferrous metal) and is at least 1/2 inch in diameter (Figure 1-2).

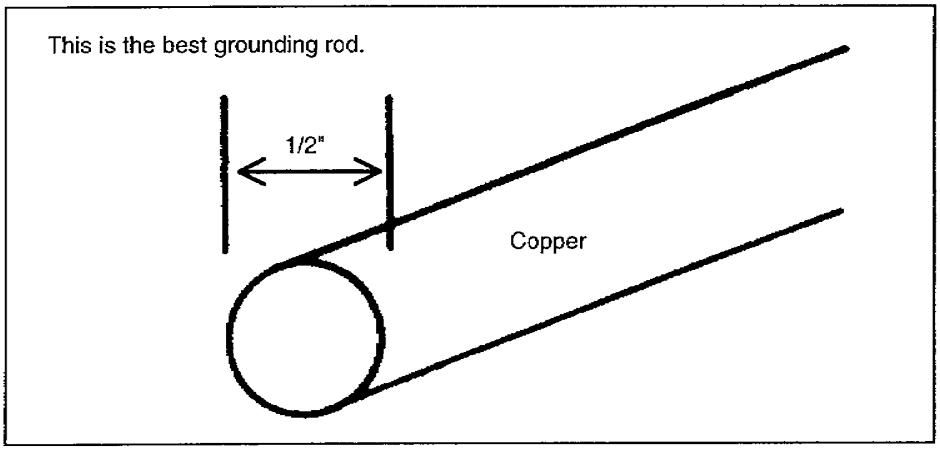

Figure 1-2. Copper grounding rod

b. A copper-coated, steel grounding rod is at least 1/2 inch in diameter (Figure 1-3).

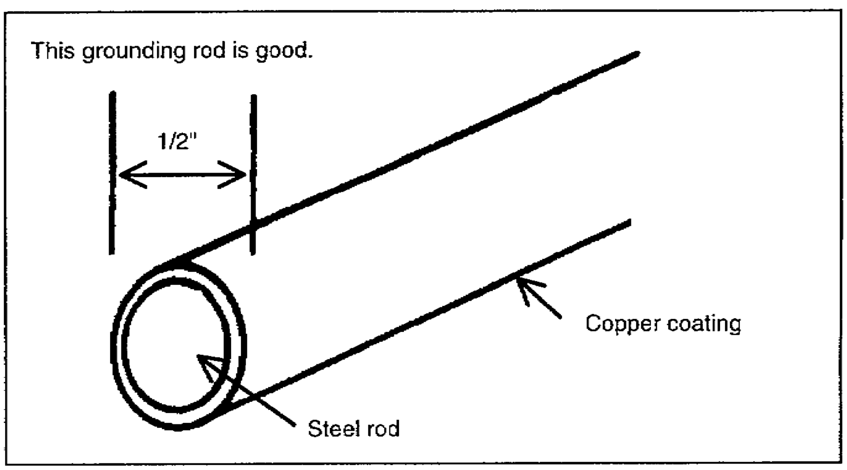

Figure 1-3. Copper-coated, steel grounding rod

c. A solid-steel (ferrous metal) grounding rod is at least 5/8 inch in diameter (Figure 1-4).

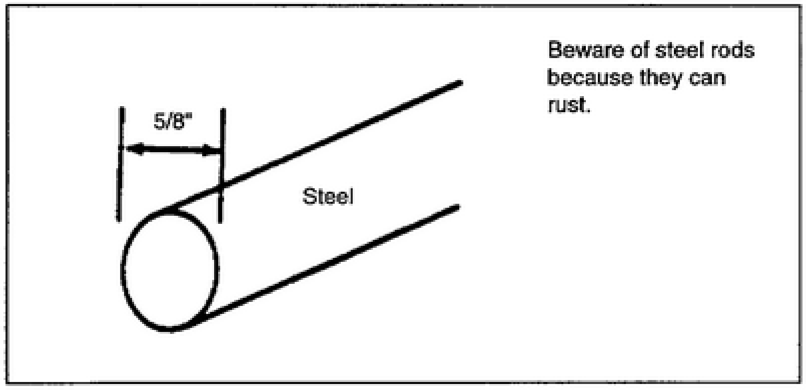

Figure 1-4. Solid-steel grounding rod

d. An iron/steel (galvanized) grounding rod is at least 3/4 inch in diameter (Figure 1-5).

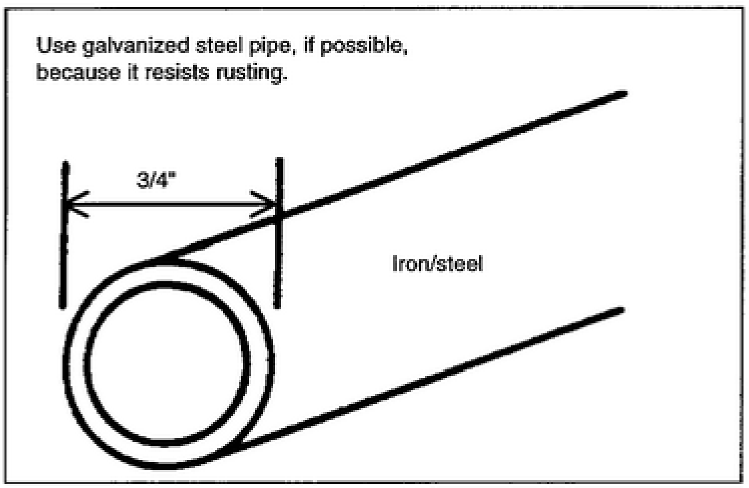

Figure 1-5. Iron/steel (galvanized) grounding rod

e. For ease of storing, some grounding rods are constructed in 3-foot sections (Figure 1-6).

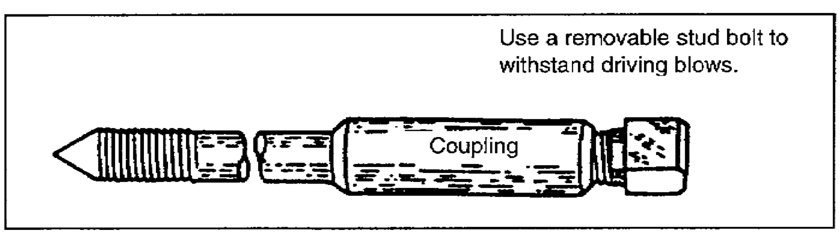

Figure 1-6. Grounding-rod sections

1-2. Installing Grounding Rods. Grounding rods are driven into the earth to a depth of at least 8 feet (Figure 1-7). This should reach the moisture level in most areas.

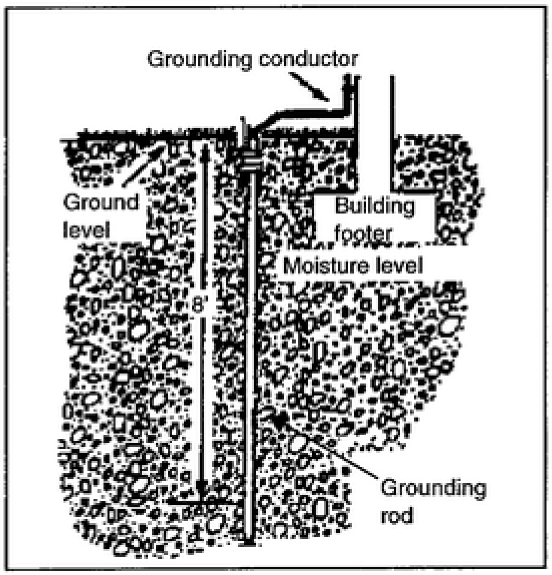

Figure 1-7. Depth of grounding rod

a. If rock is hit at less than 8 feet, the grounding rod can be driven at an angle but the angle cannot exceed 45 degrees (Figure 1-8).

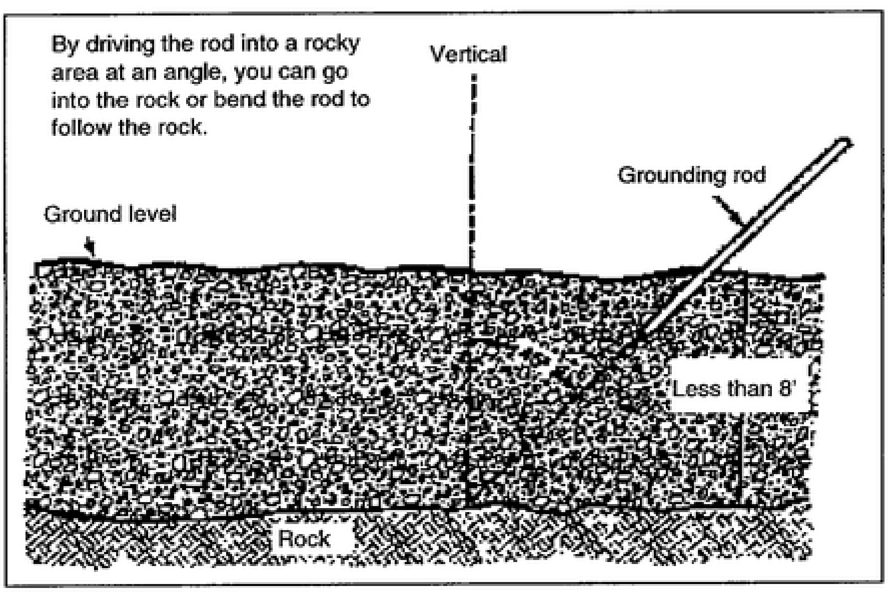

Figure 1-8. Grounding rod driven at an angle

b. A grounding rod can also be buried on top of rock in a trench that is 2 1/2 feet deep and 8 feet long (Figures 1-9 and 1-10).

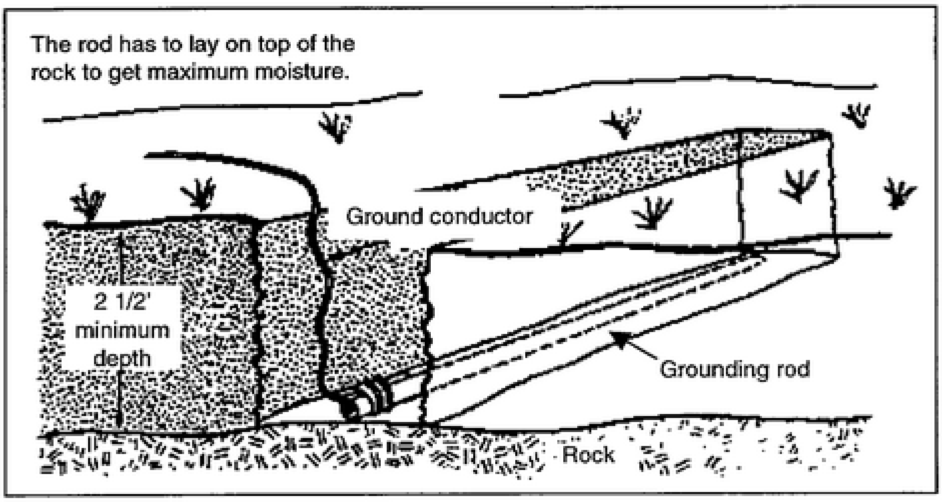

Figure 1-9. Grounding rod buried on top of rock

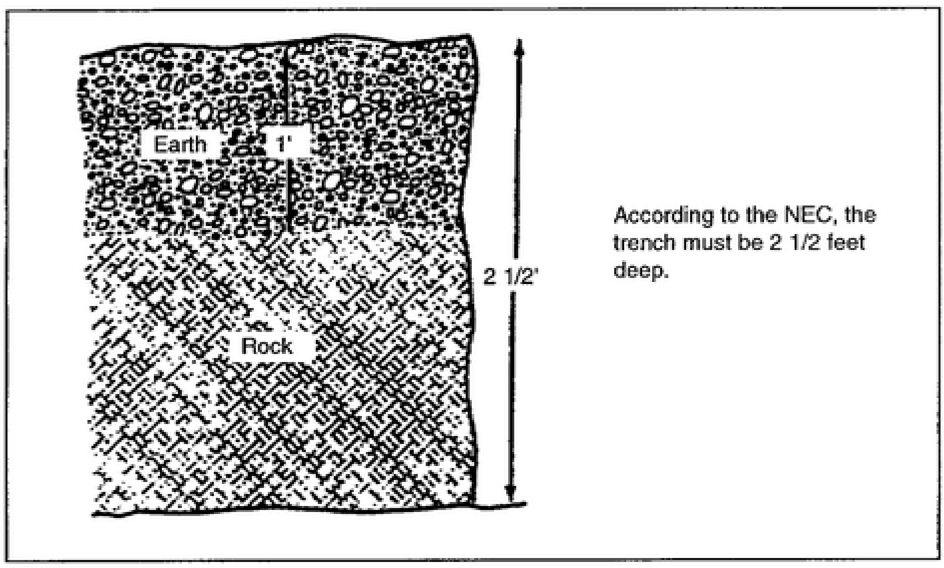

Figure 1-10. Cutting a trench

c. Ground clamps (Figure 1-11) hold the ground conductor and the grounding rod together without losing conductivity when exposed to weather and abuse. Ensure that the ground conductor is opposite to the screw-on clamp. The upper end of the grounding rod must be flush with or below ground level unless the connection is protected against physical damage.

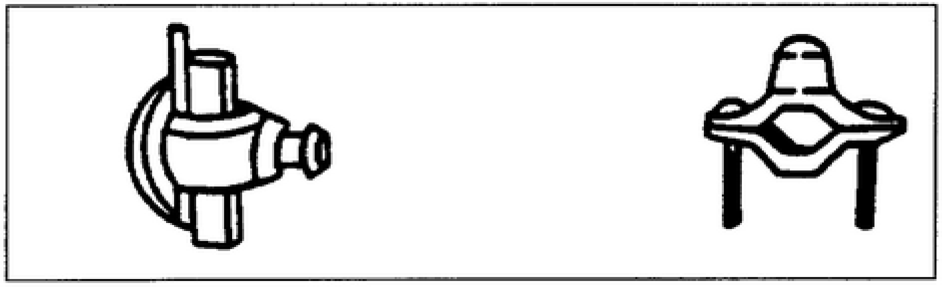

Figure 1-11. Ground clamps

1-3. Resistance. The resistance between a grounding rod and the earth should be less than 25 ohms. Check the ground resistance with a megohm meter (Figure 1-12). This check should be made with the grounding jumper between the water pipe or a good ground and the electrical system. A metallic cold-water system makes a good point for testing the resistance of an electrical grounding system. If 25 ohms to ground cannot be achieved, take the following actions:

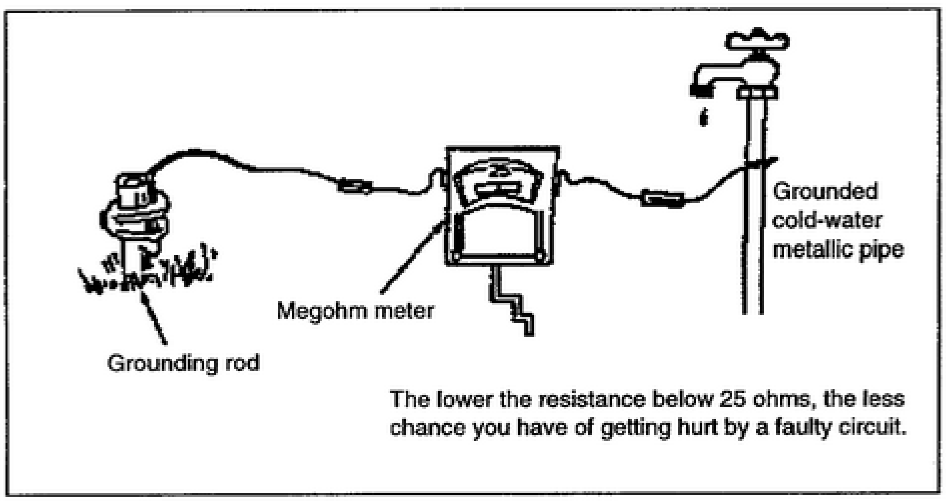

Figure 1-12. Megohm meter

a. Drive additional 8-foot grounding rods into the earth and bond them together. The rods must be at least 6 feet apart (Figure 1-13).

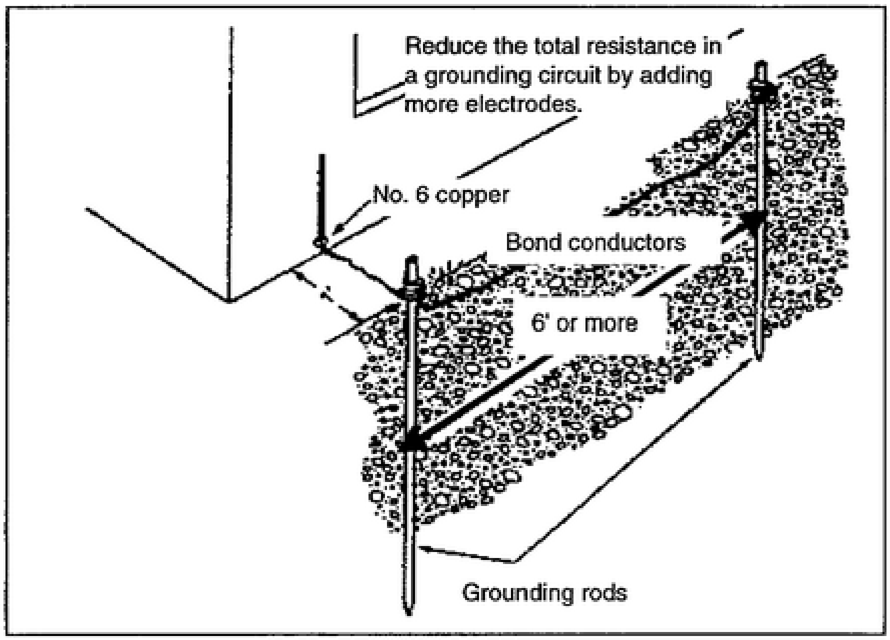

Figure 1-13. Additional grounding rods

b. Drive grounding rods deeper, if necessary, to reach the water table (Figure 1-14).

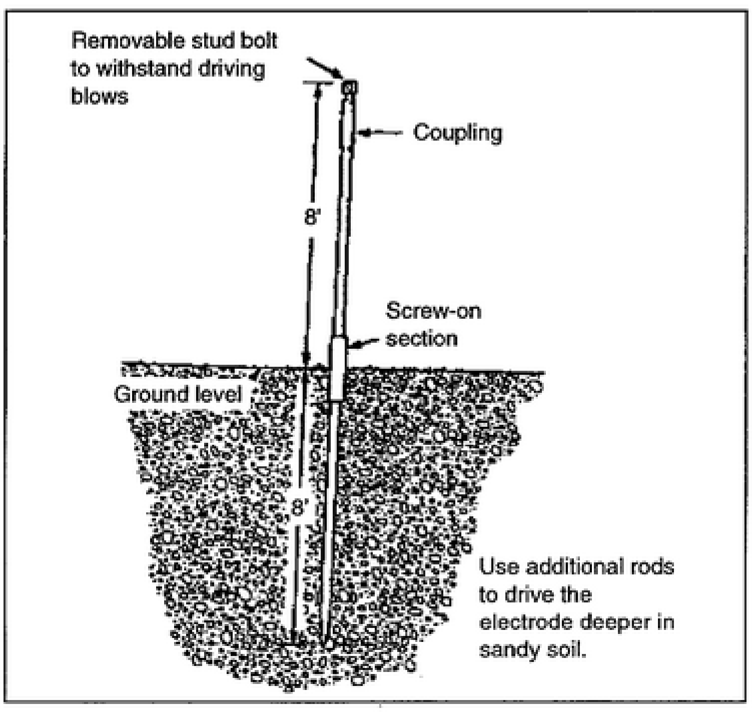

Figure 1-14. Grounding rod reaching the water table

c. Treat the soil with chemicals if the ground resistance is still over 25 ohms after using the methods described in paragraphs 1-3a and 1-3b. Treat the soil by-

- Digging a circular trench around the grounding electrode. The trench should be 1 foot deep and 9 inches away from the electrode (Figure 1-15).

- Filling the trench with 50 to 100 pounds of rock salt (copper sulfate or magnesium sulfate may also be used) and then filling the trench with water. As the water goes through the salt into the ground, resistance should be lowered. Natural rainfall will continue the process, but you must replace the rock salt every two years (Figure 1-16).

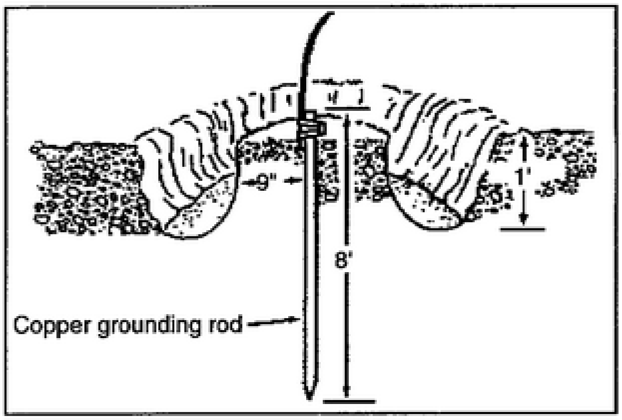

Figure 1-15. Trench dug around grounding rod

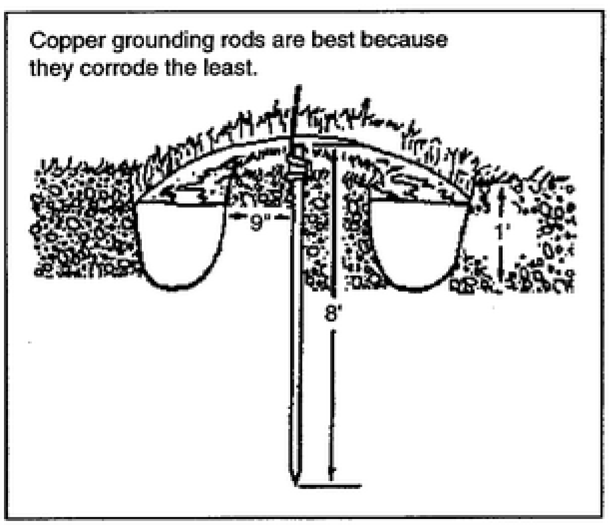

Figure 1-16. Trench filled with rock salt

1-4. Grounding Plates. Grounding plates (Figure 1-17) are sometimes required by a construction print. They offer a better grounding system than grounding rods and are generally used in permanent communication and computer sites. Unless prints or specifications call for larger plates, the total surface area of grounding plates must be 2 square feet.

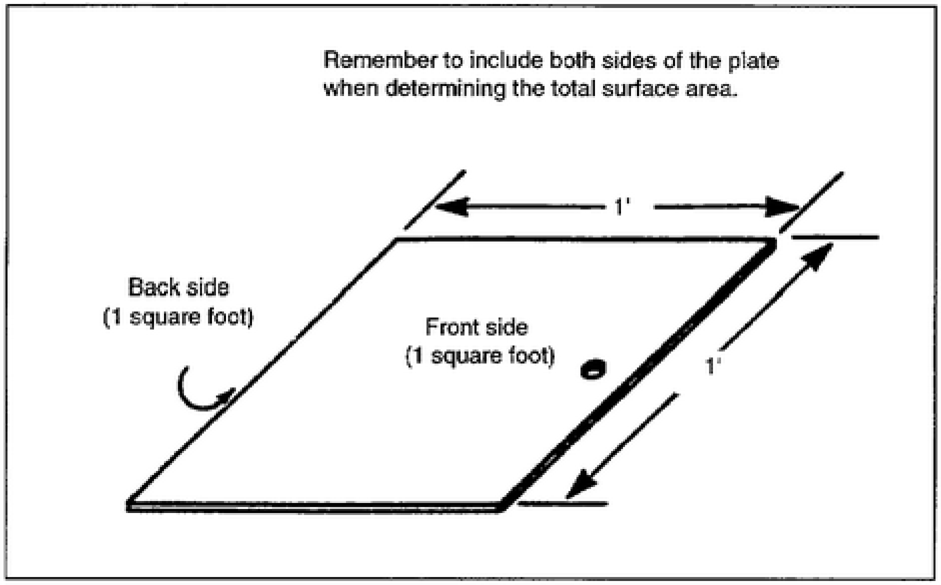

Figure 1-17. Grounding plate

a. Iron or steel grounding plates must be at least 1/4 inch thick (Figure 1-18)

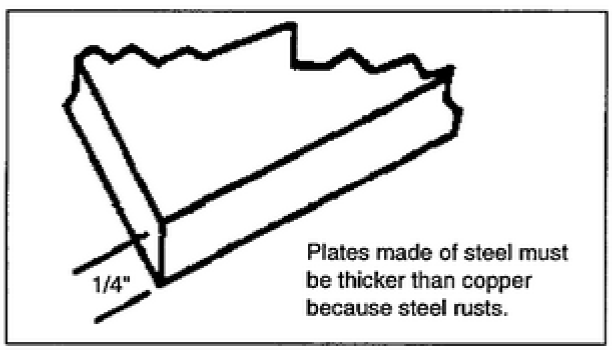

Figure 1-18. Iron or steel grounding plate

b. Nonferrous (copper or brass) grounding plates must be at least 1/16 inch thick (Figure 1-19).

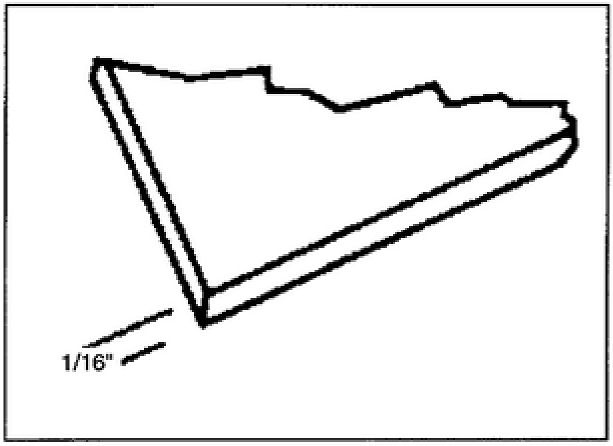

Figure 1-19. Nonferrous grounding plate

c. The copper conductor, the clamp, and the plate are bolted together (Figure 1-20).

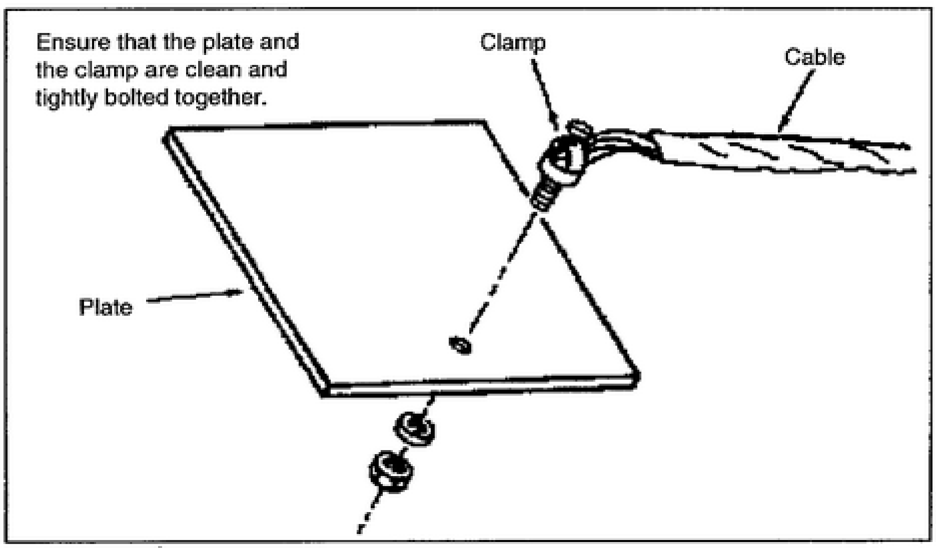

Figure 1-20. Conductor, clamp, and plate bolted together

d. Grounding plates are buried 8 feet deep, and the hole is refilled in stages (Figure 1-21).

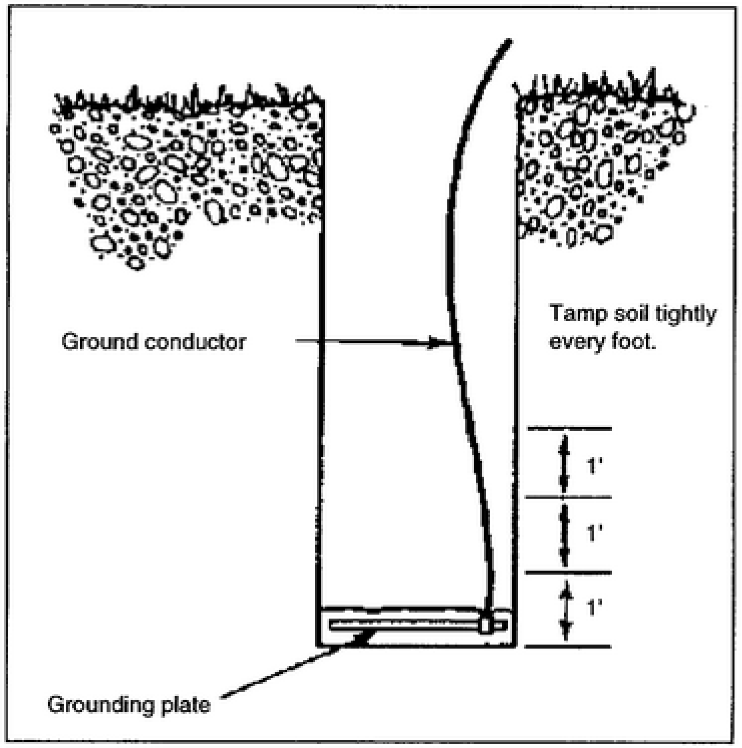

Figure 1-21. Buried grounding plate

e. The depth requirements for grounding plates are the same as those for grounding rods (Figure 1-22).

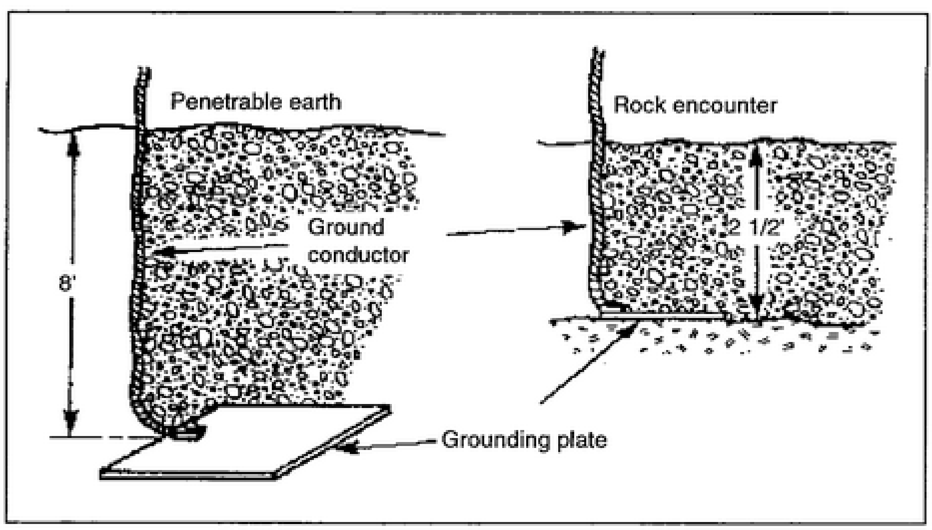

Figure 1-22. Depth of grounding plate

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LESSON 1

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer to each item. When you complete the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. What is the minimum length, in feet, of a grounding rod?

   A. 3
   B. 5
   C. 8
   D. 9

2. What are the best grounding rods made of?

   A. Copper
   B. Steel
   C. Lead
   D. Iron

3. What is the minimum diameter, in inches, of a copper grounding rod?

   A. 1/4
   B. 1/2
   C. 5/8
   D. 3/4

4. What is the minimum diameter, in inches, of a solid-steel grounding rod?

   A. 1/4
   B. 1/2
   C. 5/8
   D. 3/4

5. What is the minimum diameter, in inches, of a galvanized steel grounding rod?

   A. 1/4
   B. 1/2
   C. 5/8
   D. 3/4

6. What is the minimum distance, in feet, that a properly installed grounding rod should be driven?

A. 6
B. 8
C. 10
D. 12

7. If a grounding rod cannot be driven to the proper depth, what is the maximum angle, in degrees, that it can be driven into the earth?

A. 25
B. 35
C. 45
D. 55

8. When rock is encountered and the grounding rod cannot be driven 8 feet, what is the minimum depth, in feet, that it can be buried?

A. 1 1/2
B. 2 1/2
C. 3 1/2
D. 4 1/2

9. What is the minimum thickness, in inches, of a steel grounding plate?

A. 1/16
B. 1/8
C. 1/4
D. 1/2

10. What is the minimum thickness, in inches, of a nonferrous grounding plate?

A. 1/16
B. 1/8
C. 1/4
D. 1/2

11. At what intervals, in feet, should the soil be tamped when burying a grounding plate?

A. 1
B. 2
C. 3
D. 4

12. When additional grounding rods must be installed to get the minimum required ohm reading, what is the minimum distance, in feet, that they must be apart?

A. 3
B. 6
C. 9
D. 12

13. What should soil be chemically treated with when trying to get a better ohm reading?

A. Copper plate
B. Lead sulfate
C. Copper salt
D. Rock salt

LESSON 1

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

Item	Correct Answer and Feedback
1.	C. 8 (page 1-1, para 1-1)
2.	A. Copper (page 1-2, para 1-la)
3.	B. 1/2 (page 1-2, para 1-la)
4.	C. 5/8 (page 1-2, para l-1c)
5.	D. 3/4 (page 1-3, para 1-1d)
6.	B. 8 (page 1-4, para 1-2)
7.	C. 45 (page 1-4, para 1-2a)
8.	B. 2 1/2 (page 1-5, para 1-2b)
9.	C. 1/4 (page 1-9, para 1-4a)
10.	A. 1/16 (page 1-10, para 1-4b)
11.	A. 1(page 1-12, Figure 1-21)
12.	B. 6 (page 1-7, para 1-3a)
13.	D. Rock salt (page 1-8, para 1-3c)

LESSON 2

INSTALL CIRCUIT GROUNDS

Critical Task: 051-246-1104

OVERVIEW

LESSON DESCRIPTION:

In this lesson, you will learn to describe the procedures used to install circuit grounds.

TERMINAL LEARNING OBJECTIVE:

ACTION: You will learn to describe the procedures used to install circuit grounds.

CONDITION: You will be given the material contained in this lesson. You will work at your own pace and in your own selected environment with no supervision.

STANDARD: You will correctly answer the practice exercise questions at the end of this lesson.

REFERENCES: The material contained in this lesson was derived from STP 5-51R12-SM-TG and Section 250 of the NEC.

INTRODUCTION

As an electrician, you must know how to install circuit grounds from the panel box to all circuits. In this lesson, you will see how this is accomplished to ensure that injury or fire does not occur because of a faulty ground connection. You must be able to wire all circuits and have the proper size of conductors and connections for all circuits in the system.

2-1. Types of Conductors. Three different types of conductors are used to install grounding systems. They are copper, aluminum, and copper-coated aluminum (Figure 2-1, page 2-2).

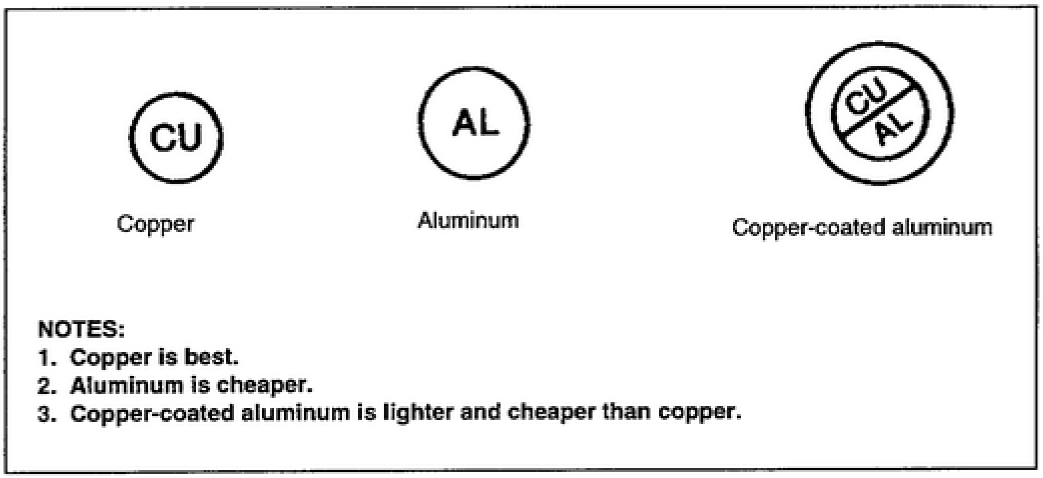

Figure 2-1. Types of conductors

a. Ground conductors are shown in Figure 2-2. If the ground conductor is covered or insulated, the material must be green.

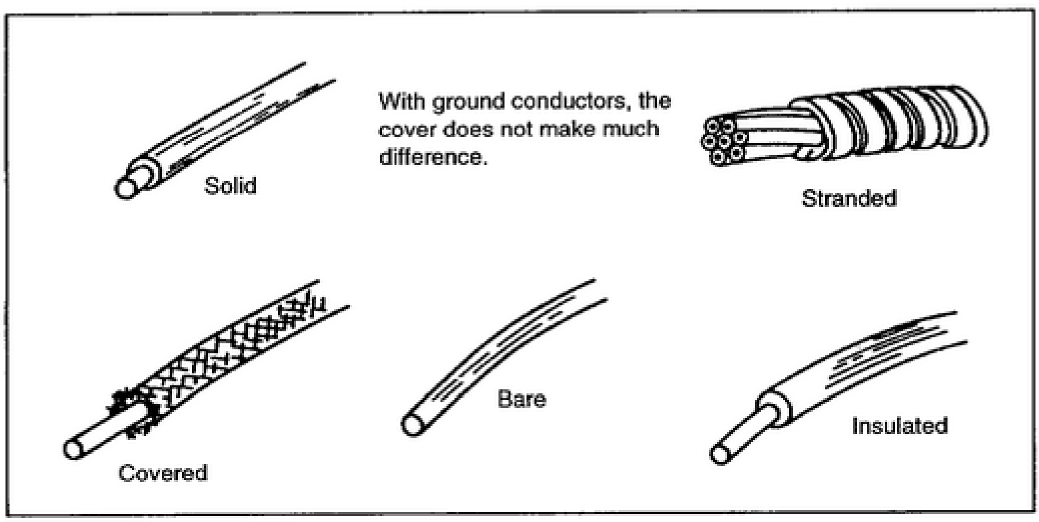

Figure 2-2. Ground conductors

NOTE: Aluminum ground conductors must be used with caution. They are soft and will not return to shape as easily as copper. When used over long periods of time, aluminum conductors can loosen in the clamp (Figure 2-3). Always check the tightness of connections when working on a system.

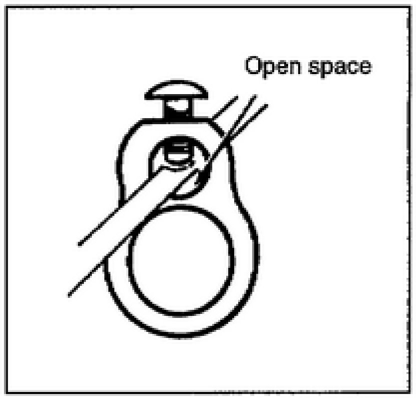

Figure 2-3. Aluminum conductors

b. The size of the conductor used between the power panel and the grounding rod is determined by the ampacity of the system being grounded. For a 100-ampere service, the ground conductor must be No. 8 copper or No. 6 aluminum (Figure 2-4).

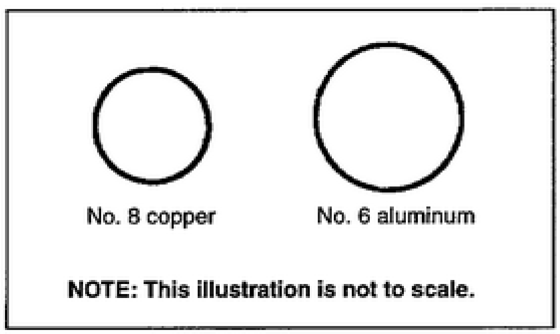

Figure 2-4. Size of conductor

c. When the grounding electrode is a high-capacity grounding system, such as metallic water or piping systems with at least 10 feet of underground pipe in contact with the soil, the system (metallic or piping) must be used as indicated in Table 2-1, page 2-4.

d. Metallic water pipe that has 10 feet or more of its length in direct contact with soil must be bonded into the grounding system (Figure 2-5, page 2-4).

Table 2-1. Grounding electrode conductor for alternating current systems

Size of Largest SE Conductor or Equivalent Area for Parallel Conductors[1] (AWG or kcmil)		Size of Grounding Electrode Conductor[2] (AWG or kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
≤2	≤1/0	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250 kcmil	4	2
>3/0-350 kcmil	>250-500 kcmil	2	1/0
>350-600 kcmil	>500-900 kcmil	1/0	3/0
>600-1,100 kcmil	>900-1,750 kcmil	2/0	4/0
>1,100 kcmil	>1,750 kcmil	3/0	250 kcmil

[1]Where multiple sets of SE conductors are used, the equivalent size of the largest SE conductor shall be determined by the largest sum of the areas of the corresponding conductors of each set.
[2]Where there are no SE conductors, the grounding electrode conductor size shall be determined by the equivalent size of the largest SE conductor required for the load to be served.

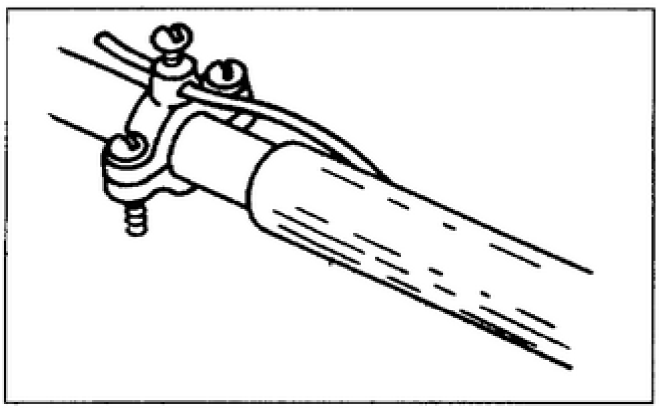

Figure 2-5. Ground conductor installed on a metallic water pipe

e. A ground conductor hooked to a metallic water system must be continuous (without splices) from the power panel, the water system, and the grounding rod (Figure 2-6).

f. Aluminum or copper-coated aluminum conductors will **not** be placed closer than 18 inches from the soil.

g. Aluminum or copper-coated aluminum conductors will **not** be placed in direct contact with masonry. When aluminum is placed in contact with soil and masonry, corrosion occurs at an accelerated rate. This corrosion is called electrolysis.

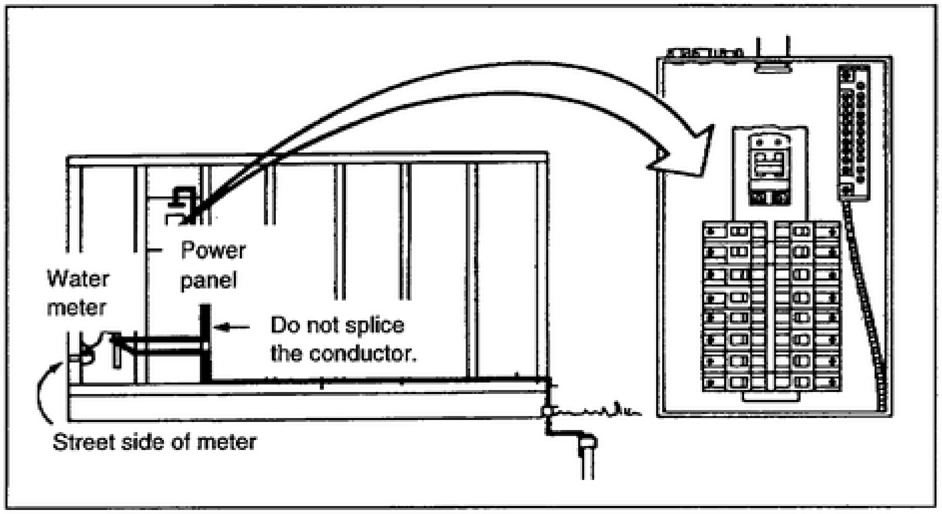

Figure 2-6. Ground conductor hooked to a metallic water system

2-2. Installing Conductors. When installing circuit grounds, use Table 2-2 to determine the proper size of conductor based on the size of the fuse or circuit breaker used.

Table 2-2. Minimum size equipment ground conductors for grounding raceway and equipment

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment and Conduit, Not Exceeding (Amperes)	Size (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum
15	14	12
20	12	10
30	10	8
40	10	8
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1,000	2/0	4/0
1,200	3/0	250
1,600	4/0	350
2,000	250	400
2,500	350	600
3,000	400	600
4,000	500	800
5,000	700	1,200
6,000	800	1,200

a. Table 2-2, page 2-5, shows the minimum size ground conductor that can be used for grounding equipment or raceways. Each ground conductor in the table has the capacity to safely carry the current required to blow a fuse or trip a circuit breaker (Figure 2-7).

NOTE: Grounding is installed to protect personnel Without the proper size ground conductor or with a broken or poorly installed ground conductor, you or someone else could become the ground conductor.

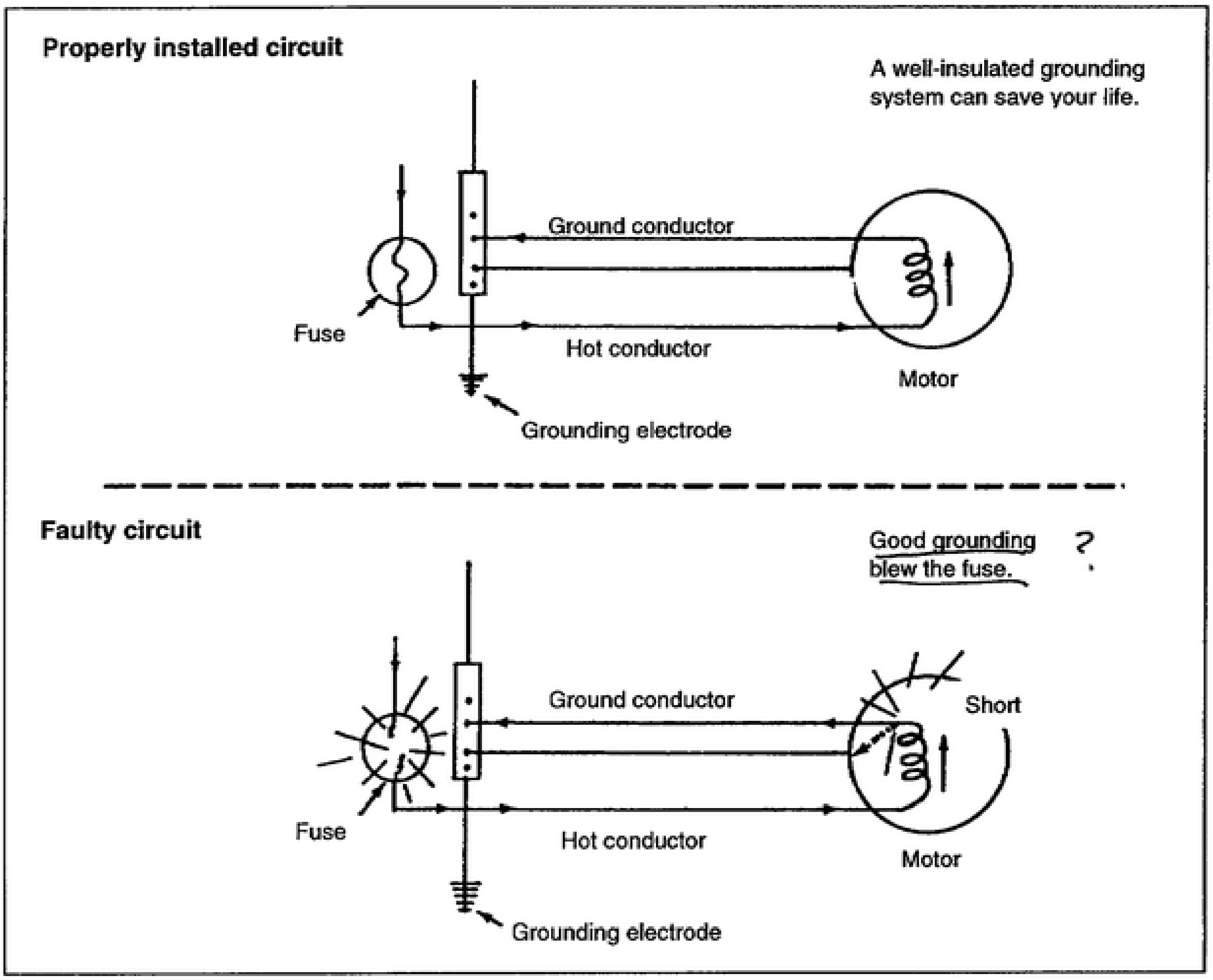

Figure 2-7. Properly installed and faulty circuits

b. In cable, such as nonmetallic sheathed cable, ground conductors can be built-in (Figure 2-8). Request cable with a ground conductor if you need a ground conductor. You do not need to worry about the size of the ground conductor in cable. However, when you pull conductors in conduit, you must select the proper size of ground conductor.

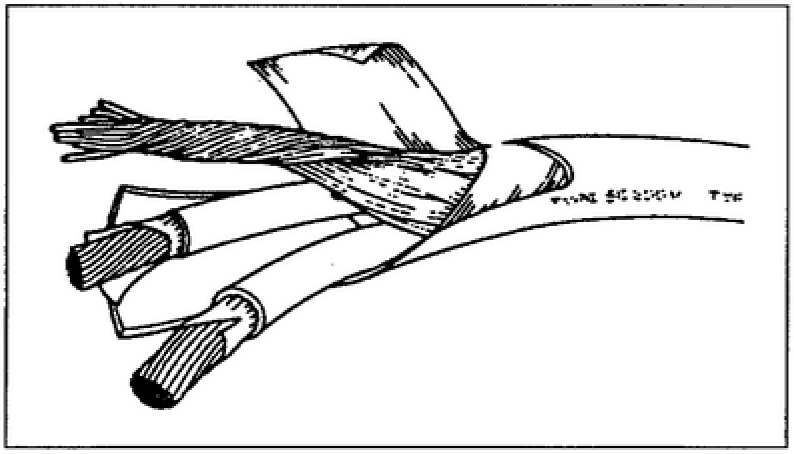

Figure 2-8. Cable with built-in ground conductor

c. The size of electrical conductors is expressed in American wire gauge (AWG). The gauge refers to the diameter of the conductor. In house (interior) wiring, the minimum size conductor allowed is No. 14 AWG. Using the AWG designation, the smaller the number, the larger the size or diameter of the conductor. For example, a No. 8 AWG conductor is larger in diameter than a No. 10 AWG conductor. Once the AWG size reaches 4/0 (spoken as 4 aught), the next larger conductor is 250 thousand circular mills (kcmil). At this point, the AWG designation reverses and the larger the number, the larger the conductor.

NOTE: If the exact amperage is not shown in the appropriate table, always go to the next larger size conductor for safety.

d. Use Table 2-2, page 2-5, and Table 2-3, page 2-8, to see the difference in conductor size between a current-carrying conductor and a ground conductor. A No. 8 moisture-resistant, thermal-plastic copper conductor can carry 40 amperes (Table 2-3); however, a ground conductor for a 40-ampere circuit must be No. 10 copper (Table 2-2). In large cables and conduit where individual conductors are used, the ground conductor or conductors are smaller than the current-carrying conductors.

Table 2-3. Allowable ampacities of insulated conductors

Size (AWG or kcmil)	Temperature Rating of Conductor						Size (AWG or kcmil)
	60°C	75°C	90°C	60°C	75°C	90°C	
	Types TW, UF	Types FEPW, RH, RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types FEPW, RH, RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	Copper			Aluminum or Copper-Clad Aluminum			
18	—	—	14	—	—	—	—
16	—	—	18	—	—	—	—
14	20	20	25	—	—	—	—
12	25	25	30	20	20	25	12
10	30	35	40	25	30	35	10
8	40	50	50	30	40	45	8
6	55	65	75	40	50	60	6
4	70	85	95	55	65	75	4
3	85	100	110	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	150	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	190	230	255	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	355	420	475	285	340	385	600
700	385	460	520	310	375	420	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	450	800
900	435	520	585	355	425	480	900
1,000	455	545	615	375	445	500	1,000
1,250	495	590	665	405	485	545	1,250
1,500	520	625	705	435	520	585	1,500
1,750	545	650	735	455	545	615	1,750
2,000	560	665	750	470	560	630	2,000
Correction Factors							
Ambient Temp (°C)	For ambient temperatures other than 30°C, multiply the allowable ampacities shown above by the appropriate factor shown below.						Ambient Temp (°F)
21-25	1.08	1.05	1.04	1.08	1.05	1.04	70-77
26-30	1.00	1.00	1.00	1.00	1.00	1.00	78-86
31-35	0.91	0.94	0.96	0.91	0.94	0.96	87-95
36-40	0.82	0.88	0.91	0.82	0.88	0.91	96-104
41-45	0.71	0.82	0.87	0.71	0.82	0.87	105-113
46-50	0.58	0.75	0.82	0.58	0.75	0.82	114-122
51-55	0.41	0.67	0.76	0.41	0.67	0.76	126-131
56-60	—	0.58	0.71	—	0.58	0.71	132-140
61-70	—	0.33	0.58	—	0.33	0.58	141-158
71-80	—	—	0.41	—	—	0.41	159-176

2-3. Ground Conductors. The grounding of boxes is very important. All metal boxes in a circuit must be grounded. The ground conductor connects all metal boxes and electrical equipment to the panel box. The panel box is connected to the grounding rod, so that all boxes and electrical equipment are connected to the grounding rod and the earth ground.

a. When ground conductors are twisted together, they must be secured to prevent them from coming apart. A wire nut (Figure 2-9) or a splice cap (Figure 2-10) can be used to hold the twisted ground conductors together.

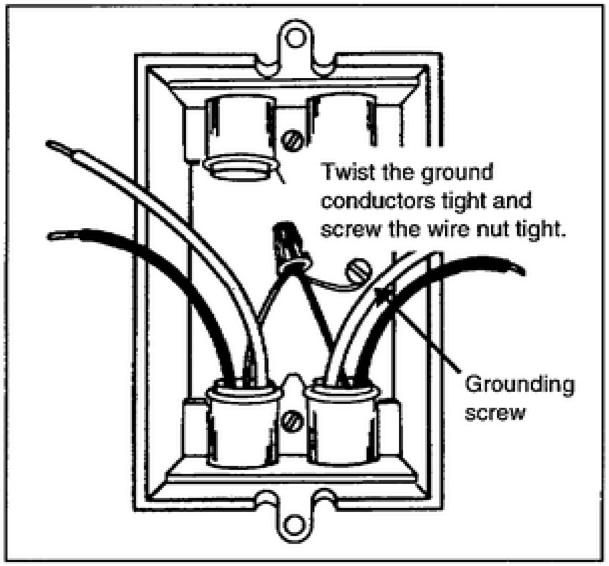

Figure 2-9. Wire nut holding twisted ground conductors

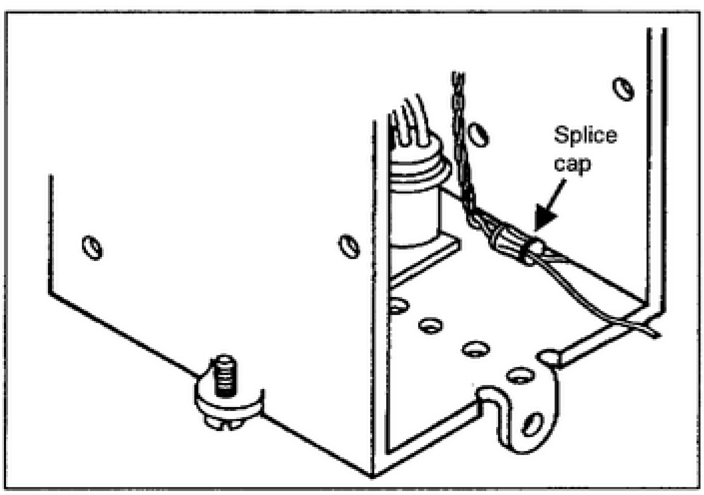

Figure 2-10. Splice cap holding twisted ground conductors

b. You can bond the grounding system to the box with a grounding screw, but this screw can have no other purpose than to hold the ground conductor to the box (Figure 2-9, page 2-9).

c. Another method is to use a grounding clip (Figure 2-11). The grounding clip slides over the box and the ground conductor. The ground conductor fits in the groove of the grounding clip, and the grounding clip holds the ground conductor securely to the metal box.

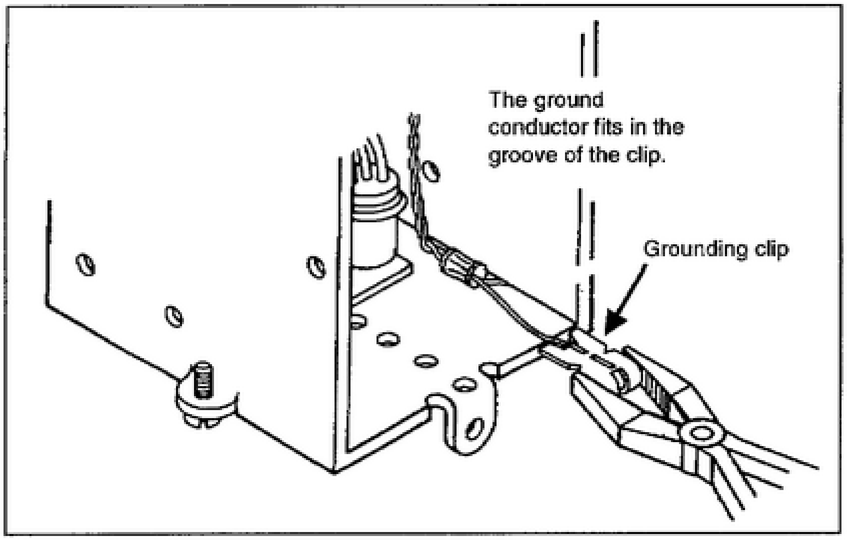

Figure 2-11. Grounding clip holding the ground conductor

d. To avoid installing ground conductors incorrectly, remember these important points:

- Do not bond more than one ground conductor to a box. Twist ground conductors together and bond them to the box as one.

- Do not place two ground conductors under one screw. Twist ground conductors together and place them under the screw as one.

- Do not use the internal clamp screw to hold the ground conductor to the box. This screw is being used to hold the cable clamp and should not be used to hold the ground conductor.

LESSON 2

PRACTICE EXERCISE

The following items will test your grasp of the material covered in this lesson. There is only one correct answer for each item. When you complete the exercise, check your answer with the answer key that follows. If you answer any item incorrectly, study again that part of the lesson which contains the portion involved.

1. Which conductor is best?

   A. Copper
   B. Aluminum
   C. Copper-covered aluminum
   D. Steel

2. Ground conductors must be made of stranded wires.

   A. True
   B. False

3. Aluminum ground conductors are better to use in an electrical circuit because they do not loosen in the damp.

   A. True
   B. False

4. What size copper ground conductor is needed for a service-entrance cable with a 4/0 copper conductor (see Table 2-1, page 2-4)?

   A. No. 2
   B. No. 4
   C. No. 6
   D. No. 8

5. Metallic water pipe must be bonded to the grounding system if it is in direct contact with soil for a minimum of how many feet?

   A. 8
   B. 10
   C. 12
   D. 14

6. What is the closest distance, in inches, that an aluminum conductor used for grounding can be placed to the earth?

A. 14
B. 18
C. 20
D. 24

7. What size equipment ground must be used with a 60-ampere circuit using a copper conductor (see Table 2-2, page 2-5)?

A. No. 4
B. No. 6
C. No. 8
D. No. 10

8. What size copper equipment ground conductor must be used when you are installing a 20-ampere circuit in conduit (see Table 2-2, page 2-5)?

A. No. 12
B. No. 10
C. No. 8
D. No. 6

9. The internal clamp screw should be used to hold the ground conductor to a metal box.

A. True
B. False

10. Ground conductors can be preinstalled in cable.

A. True
B. False

11. The ground conductors inside the outlet box in Figure 2-12 are properly installed?

A. True
B. False

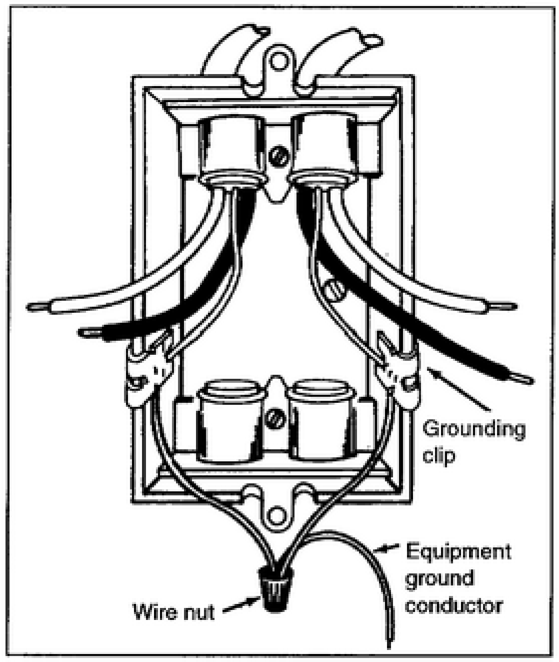

Figure 2-12. Outlet box

LESSON 2

PRACTICE EXERCISE

ANSWER KEY AND FEEDBACK

Item	Correct Answer and Feedback
1.	A. Copper (page 2-2, Figure 2-1)
2.	B. False (page 2-2, Figure 2-2)
3.	B. False (page 2-2, Note)
4.	A. No. 2 (page 2-4, Table 2-1)
5.	B. 10 (page 2-3, para 2-1d)
6.	B. 18 (page 2-4, para 2-1f)
7.	C. No. 10 (page 2-5, Table 2-2)
8.	A. No. 12 (page 2-5, Table 2-2)
9.	B. False (page 2-10, para 2-3d)
10.	A. True (page 2-7, para 2-2b)
11.	B. False (page 2-10, para 2-3d)

APPENDIX A

METRIC CONVERSION CHART

This appendix complies with current Army directives which state that the metric system will be incorporated into all publications. Table A-1 is a conversion chart.

Table A-1. Metric conversion chart

Multiply US Units	By	To Obtain Metric Units
Degrees Celsius +17.8	1.8	Degrees Fahrenheit
Feet	0.305	Meters
Inches	2.54	Centimeters
Inches	25.4001	Millimeters

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APPENDIX B

LIST OF COMMON ACRONYMS

ACCP	Army Correspondence Course Program
APD	Army Institute for Professional Development
AL	aluminum
AMEDD	Army Medical Department
APO	Army Post Office
AV	Automatic Voice Network
AVG	American wire gauge
°C	degrees Celsius
CU	copper
DETC	Distance Education and Training Council
DINFOS	Defense Information School
DOD	Department of Defense
DSN	Defense Switched Network
EN	engineer
°F	degrees Fahrenheit
FM	field manual
ICE	Interservice Correspondence Exchange
IPD	Institute for Professional Development
JFK	John F. Kennedy
kcmil	thousand circular mils

MA	Massachusetts
MI	middle initial
MO	Missouri
MOS	military occupational specialty
NEC	National Electrical Code
No.	number
para	paragraph
RCOAC	Reserve Component Officer's Advanced Course
reg	regulation
RYE	retirement year ending
SE	service entrance
SGT	sergeant
SM	soldier's manual
SSN	social security number
STP	soldier training publication
temp	temperature
TG	trainer's guide
TM	technical manual
TRADOC	United States Army Training and Doctrine Command
US	United States
VA	Virginia

APPENDIX C

RECOMMENDED READING LIST

These publications provide additional information about the material in this subcourse. You do not need these materials to complete this subcourse.

FM 5-424. *Theater of Operations Electrical Systems*. 25 June 1997

STP 5-51R12-SM-TG. *Soldier's Manual and Trainer's Guide*, *MOS 51R, Interior Electrician, Skill Levels 1/2*. 27 October 1988.

National Electrical Code, 1999 Edition, National Fire Protection Association, Publications, Batterymarch Park, Quincy, MA 02269. 1999.

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